ICCA STROKE 2019

WIST

Perfusion-Is it always necessary?

Annie Chakrabarti

Consultant Stroke Physician

Norfolk & Norwich University Hospital

U.K.

DISCLOSURE STATEMENT OF FINANCIAL INTEREST

Within the past 12 months, I have had a financial interest/arrangement or affiliation with the organizations listed below

Bayer
Pfizer
Bristol- Mayer Squibbs
Daichii sankyo
Aliqua Companies Ltd.

DISCLOSURE STATEMENT OF FINANCIAL INTEREST

I, (Annie Chakrabarti)DO NOT have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.

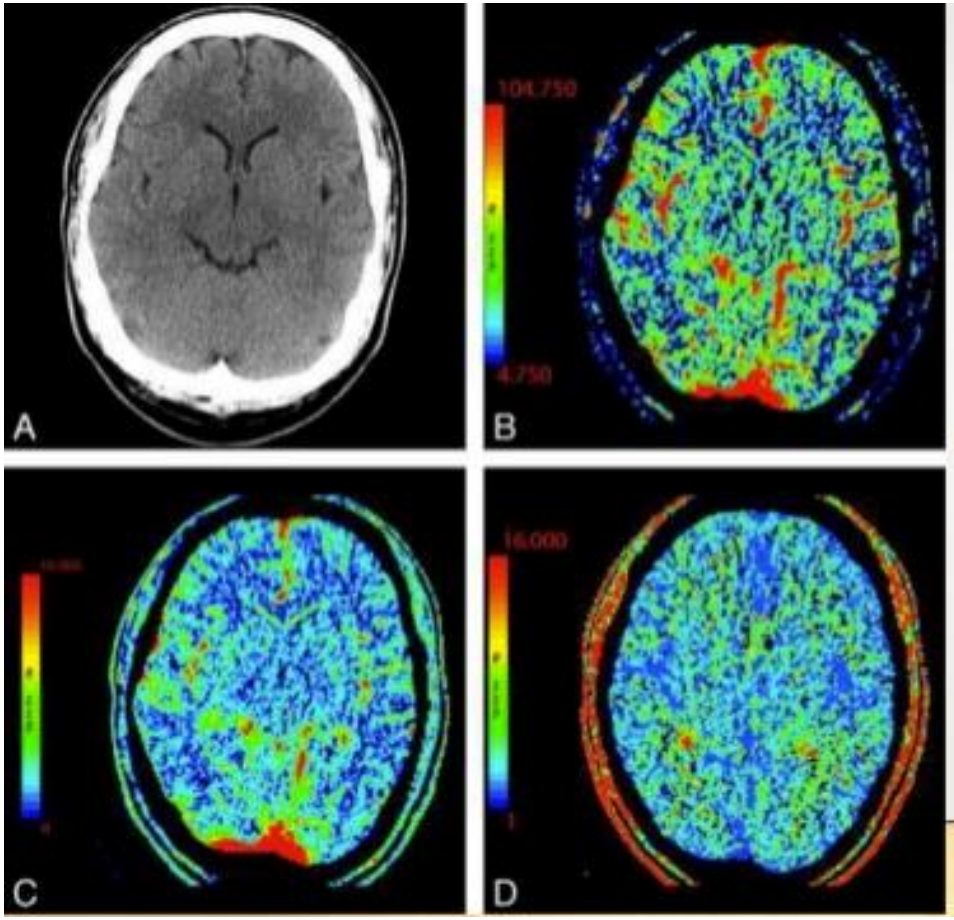
Overview

- Background for perfusion scan in stroke treatment
- Updates from recent studies - significance of perfusion scanning
- Conclusion

Introduction

- Perfusion computed tomography (CT) allows functional evaluation of tissue vascularity.
- It measures the **temporal changes in tissue density** after intravenous injection of a contrast medium (CM) bolus using a series of dynamically acquired CT images.
- The greatest impact of perfusion CT has been on the assessment of patients who have had **strokes**, wherein the rapid scan timing and faster image processing have cemented its role as the modality of choice for evaluation of structural and functional status of cerebral vasculature.

CT perfusion(Normal)



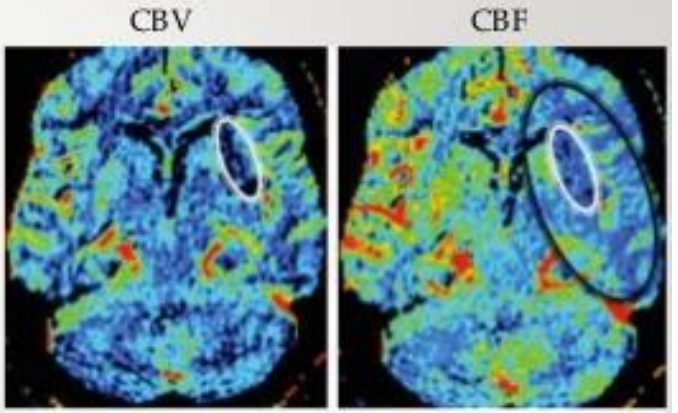
Normally by convention, all color maps are coded RED for higher values and BLUE for lower values.

NCCT (A), CTP parametric maps, CBF (B), CBV(C), MTT(D), Demonstrate normal symmetric brain perfusion.

CT perfusion (stroke)

Contd…

- CT perfusion maps of cerebral blood volume (a) and cerebral blood flow (b) show, in the left hemisphere, a region of decreased blood volume (white oval) that corresponds to the ischemic core and a larger region of decreased blood flow (black oval in b) that includes the ischemic core and a peripheral region of salvageable tissue. The difference between the two maps (black oval-white oval) is the penumbra.
- The penumbra phase generally begins when blood flow falls below 20 mL/100 g/min and electrical communication between neurons cease with infarction not occurring until blood flow falls below 10 or 12 mL/100 gm/min.



Perfusion parameter	Infarct core	Ischemic penumbra
CBF	Reduced	Reduced
CBV	Reduced	Normal or increased
MTT	Prolonged	Prolonged
TTP	Prolonged	Prolonged

ICCA STROKE 2019

WIST

Time is Brain

Updates from recent studies

ICCA STROKE 2019

WIST

Standards

European Stroke Organisation (ESO) - European Society for Minimally Invasive Neurological Therapy (ESMINT) Guidelines on Mechanical Thrombectomy in Acute Ischemic Stroke

Guillaume Turc,[1,2,3,4] Pervinder Bhogal,[5] Urs Fischer,[6] Pooja Khatri,[7] Kyriakos Lobotesis,[8] Mikaël Mazighi,[3,9,10,11] Peter D. Schellinger,[12] Danilo Toni,[13] Joost de Vries,[14] Philip White,[15] Jens Fiehler[16]

QUESTION

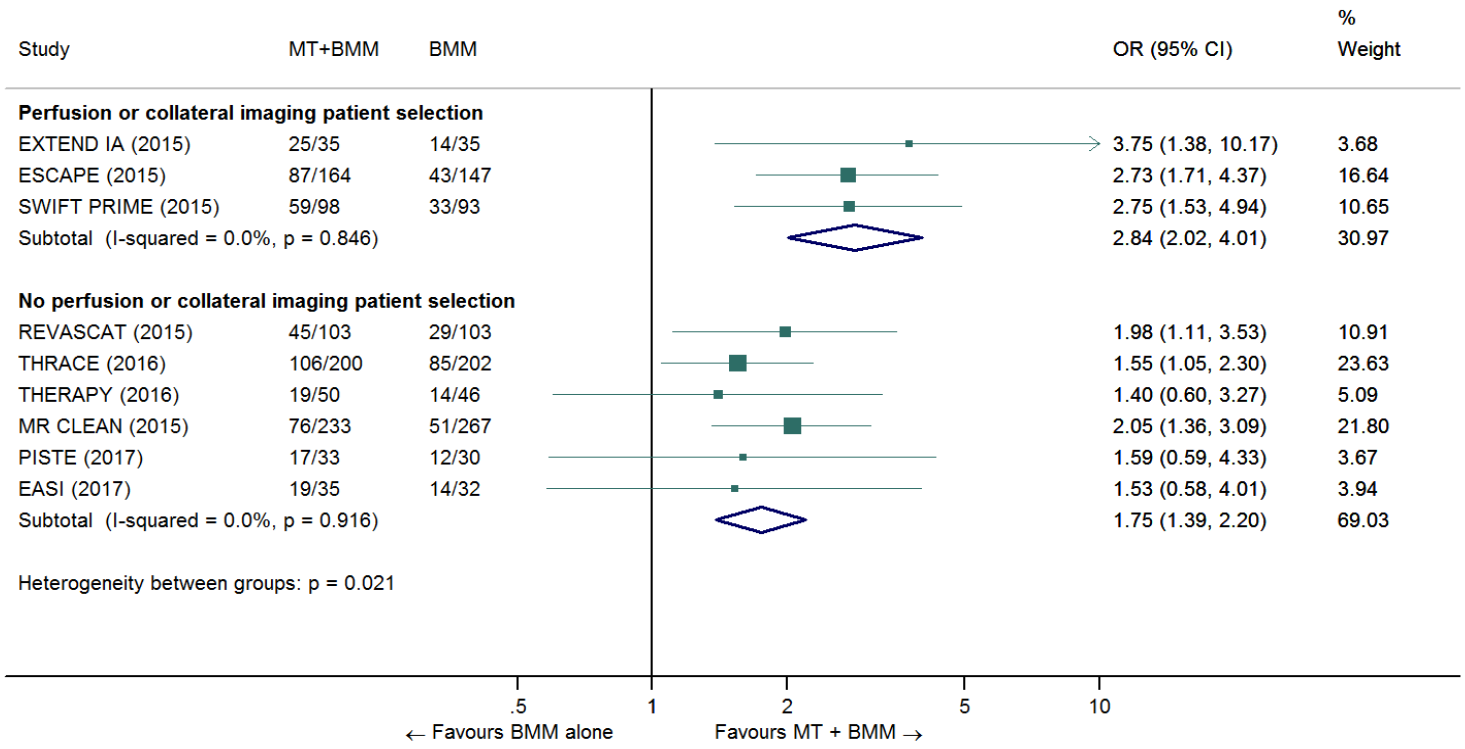
- PICO 9: FOR ADULTS WITH LARGE VESSEL OCCLUSION-RELATED ACUTE ISCHEMIC STROKE, DOES SELECTION OF MECHANICAL THROMBECTOMY CANDIDATES BASED ON ADVANCED PERFUSION, CORE OR COLLATERAL IMAGING COMPARED WITH NO ADVANCED IMAGING: (A) IMPROVE IDENTIFICATION OF PATIENTS WITH A THERAPY EFFECT OF THROMBECTOMY ON FUNCTIONAL OUTCOME? (B) DECREASE THE RISK OF SYMPTOMATIC INTRACEREBRAL HEMORRHAGE?

J NeuroIntervent Surg: first published as 10.1136/neurintsurg-2018-014569 on 26 February 2019. 4 March 2019 http http://jnis.bmj.com/J

ICCA STROKE 2019

WIST

PICO 9: Benefit of MT according to advanced imaging patient selection: mRS 0-2



Therapy effect of MT plus BMM versus BMM alone on functional independence, according to advanced imaging patient selection. Unadjusted pooled odds ratios, fixed-effect meta-analyfixed-effect meta-analysis.

BMM, best medical management; mRS, modified

Conclusion

- Patients with anterior circulation LVO related acute ischaemic stroke presenting within 0-6 hours from time last known well- advanced imaging not necessary for patient selection

- Patients with anterior circulation LVO related ischemic stroke presenting beyond 6 hours from time last known well, advanced imaging selection is necessary

J NeuroIntervent Surg: first published as 10.1136/neurintsurg-2018-014569 on 26 February 2019. 4 March 2019 http http://jnis.bmj.com/J

Powers et al 2018 Guidelines for Management of Acute Ischemic Stroke

7. Multimodal CT and MRI, including perfusion imaging, should not delay administration of IV alteplase.	**III: Harm**	**B-NR**	New recommendation.
Analysis of trials using advanced, multimodal pretreatment imaging (including CTP measures of penumbral imaging, diffusion-perfusion mismatch, or vessel imaging) for IV fibrinolytics has failed to demonstrate clinical efficacy in patients with various pretreatment imaging biomarkers compared with those without those markers.[88–95]			See Table XX and XXI in online Data Supplement 1.

ORIGINAL RESEARCH

Simplified selection criteria for patients with longer or unknown time to treatment predict good outcome after mechanical thrombectomy

Simon Nagel,[1] Christian Herweh,[2] Johannes Alex Rolf Pfaff,[2] Simon Schieber,[1] Silvia Schönenberger,[1] Markus A Möhlenbruch,[2] Martin Bendszus,[2] Peter Arthur Ringleb[1]

Methodology

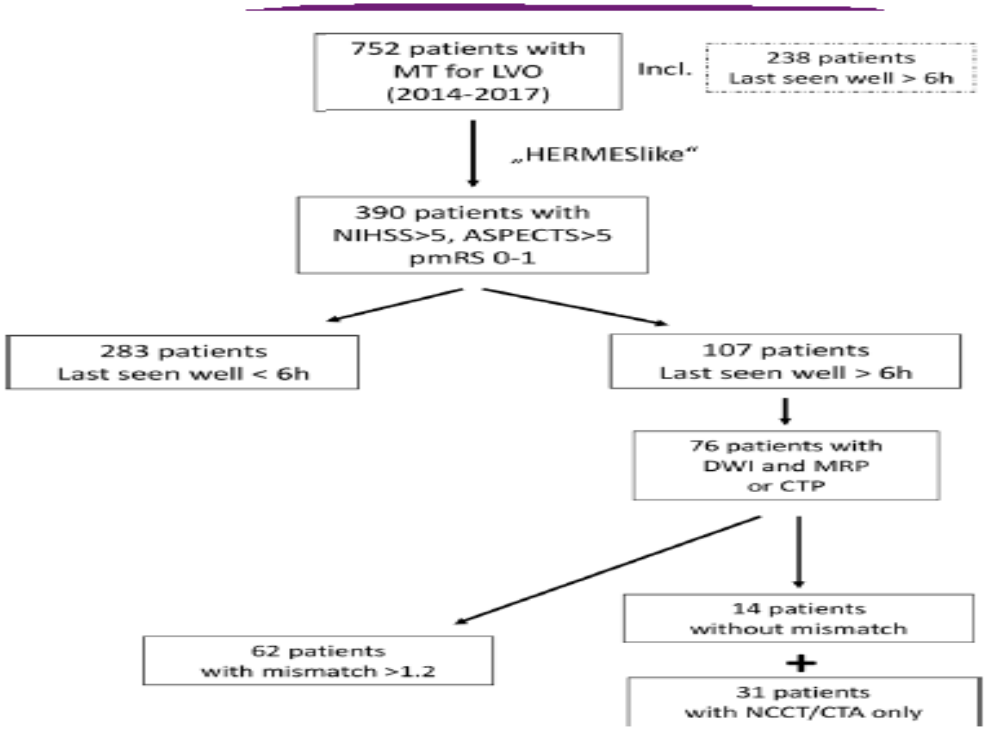
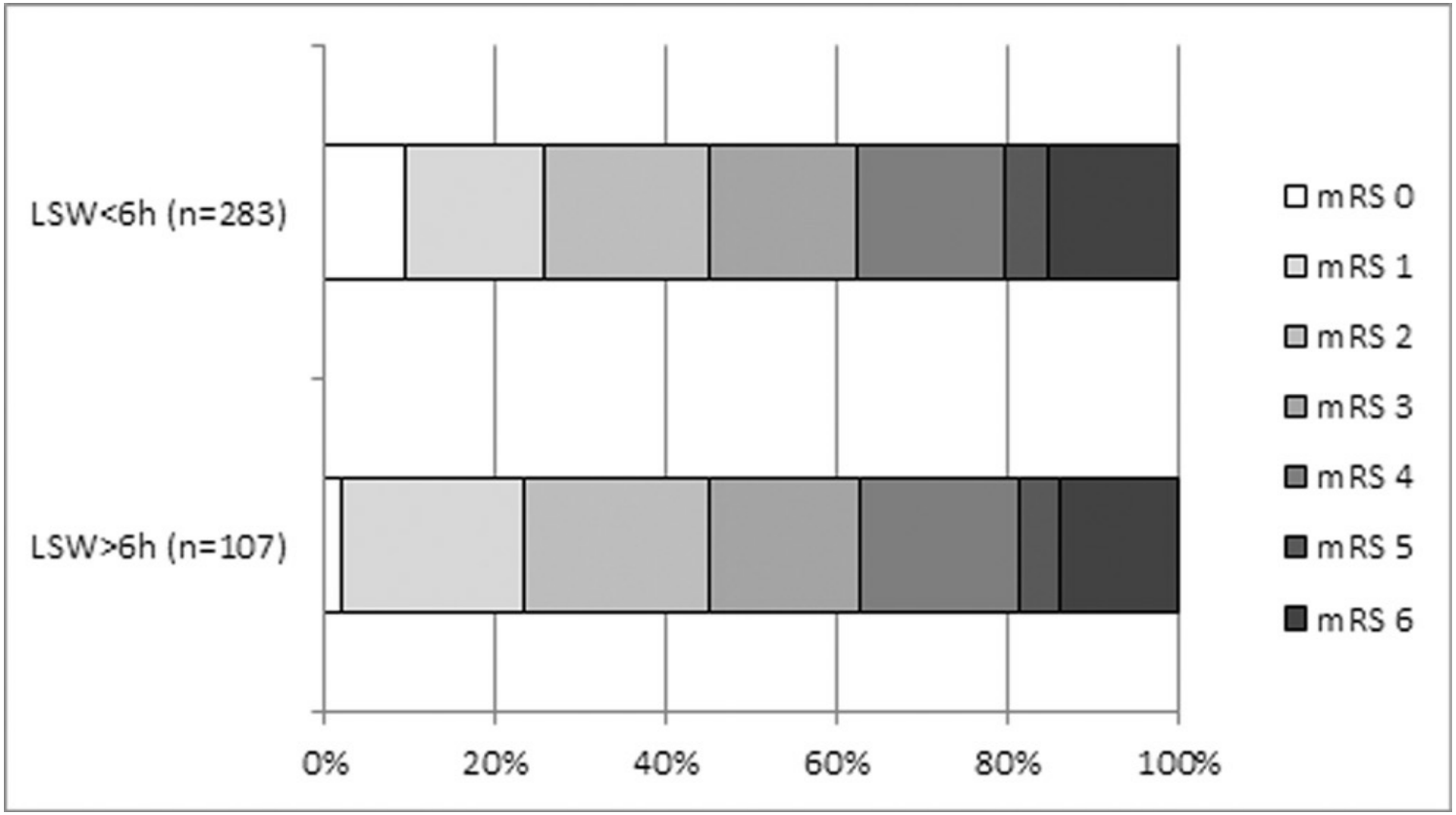


Figure 1 Flowchart of patients. ASPECTS, Alberta Stroke Programme Early CT Score; CTA, CT angiography; CTP, CT perfusion; DWI, diffusion-weighted imaging; LVO, large vessel occlusion; MRP, magnetic resonance perfusion; MT, mechanical thrombectomy; NCCT, non-contrast-enhanced CT; NIHSS, National Institute of Health Stroke Scale; pmRS, premorbid modified Rankin Scale.

Clinical outcome after 90 days on the mRS scale in HERMES patients (n=390)LSW, LAST SEEN WELL



Variables associated with primary end point and their respective OR in unadjusted & adjusted analysis

Variable	Unadjusted OR (95% CI)	P values	Adjusted OR (95% CI)	P values
Age	0.97 (0.95 to 0.98)	<0.001	0.96 (0.95 to 0.98)	<0.001
Premorbid mRS 1	0.6 (0.4 to 0.9)	0.015	0.75 (0.47 to 1.2)	0.23
NIHSS	0.94 (0.9 to 0.97)	0.001	0.92 (0.88 to 0.96)	<0.001
ASPECTS	1.26 (1.07 to 1.47)	0.005	1.25 (1.06 to 1.49)	0.008
General anesthesia	0.17 (0.37 to 0.74)	0.019	0.2 (0.04 to 0.99)	0.05
Successful recanalization	8.5 (3.6 to 20.4)	<0.001	12 (4.7 to 30.5)	<0.001

ASPECTS, Alberta Stroke Programme Early CT Score; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

Conclusion

- Patient with proven LVO in unknown & longer time windows may be selected for mechanical thrombectomy based on ASPECTS & clinical criteria

CASE SERIES

Admission CT perfusion may overestimate initial infarct core: the ghost infarct core concept

Sandra Boned,[1,2] Marina Padroni,[3] Marta Rubiera,[1,2] Alejandro Tomasello,[4] Pilar Coscojuela,[4] Nicolás Romero,[4] Marián Muchada,[1,2] David Rodríguez-Luna,[1,2] Alan Flores,[1,2] Noelia Rodríguez,[1,2] Jesús Juega,[1,2] Jorge Pagola,[1,2] José Alvarez-Sabin,[1,2] Carlos A Molina,[1,2] Marc Ribó[1,2]

Aim of the study

- To characterise cases in which the admission core lesion on CTP does not reflect an infarct on follow up imaging

Ghost core Infarct (GIC)

- Initial core infarct minus final infarct>10ml
- Admission core infarct was measured on initial cerebral blood volume (CBV) CTP and final infarct on follow up CT.

Baseline characteristics

	All patients n=79	GIC>10 mL n=30	No GIC n=49	p Value
Sex (female/male)	50/29	16/14	30/19	0.286
Age (years), mean±SD	68±13	71±12	67±13	0.196
Hypertension (%)	66.2%	63%	65%	0.580
Diabetes mellitus (%)	16.7%	13%	16%	0.462
Atrial fibrillation (%)	30.8%	26%	24%	0.215
Hyperlipidemia (%)	41%	43%	38%	0.419
Admission glycemia (mg/dL), mean±SD	126.9±45	117±27	132±54	0.199
NIHSS admission, median (IQR)	17 (11–20)	16 (11–21)	14 (8–20)	0.451
NIHSS 24 hours, median (IQR)	11 (3–19)	9 (2–16)	12 (4–20)	0.084
NIHSS improvement at 24 hours, median (IQR)	3 (0–9)	7 (1–14)	2 (0–5)	0.005
Clinical improvement (%)	48.1%	66.6%	39%	0.017
CT ASPECTS admission, median (IQR)	9 (8–10)	9 (8–10)	10 (8–10)	0.549
IV tPA pretreatment (%)	58.2%	56.6%	54.2%	0.508
Occlusion location	–	–	–	0.611
MCA-M1 (%)	35 (44.3%)	16 (53.3%)	20 (40.8%)	
MCA-M2 (%)	16 (20.2%)	5 (16.6%)	11 (22.4%)	
Terminal ICA (%)	21 (26.5%)	6 (20%)	14 (28.5%)	
Tandem ICA/MCA (%)	7 (8.8%)	3 (10%)	4 (8%)	
TOAST	–	–	–	0.294
Atherothrombotic (%)	14 (17.7%)	2 (6%)	12 (24.4%)	
Cardioembolic (%)	45 (56.9%)	20 (66.6%)	23 (46.9%)	
Undetermined (%)	13 (16.4%)	4 (13.3%)	9 (18.3%)	
Other determined (dissections)	7 (8%)	4 (13.3%)	3 (6%)	

ASPECTS, Alberta Stroke Program Early CT Score; GIC, ghost infarct core; ICA, internal carotid artery; IV tPA, IV tissue-type plasminogen activator; MCA, middle cerebral artery; NIHSS, National Institutes of Health Stroke Scale; TOAST, trial of ORG 10172 in acute stroke treatment.

Clinical Outcome and lesion volumes

	All patients n=79	GIC >10 mL n=30	No GIC n=49	p Value
Symptom onset to CTP	215 (87–327)	165 (66–323)	222 (118–340)	0.138
Time from CTP to recanalization	119 (88–159)	136 (85–171)	234±144	0.575
Recanalization rate (TICI 2b–3)	77%	90%	68%	0.026
CBV infarct core, mL	27 (2–65)	65 (46–92)	30 (0–27)	<0.001
Final infarct volume, mL	12 (2–45)	10 (4–26)	13 (1–63)	0.639
mRS <2 at 90 days (%)	39.7%	61.1%	27.3%	0.036
SICH (%)	5.4%	0%	6.3%	0.222

CBV, cerebral blood volume; CTP, CT perfusion; GIC, ghost infarct core; mRS, modified Rankin Scale; SICH, symptomatic intracranial hemorrhage; TICI, Thrombolysis In Cerebral Infarction perfusion scale grade.

Neuroimaging

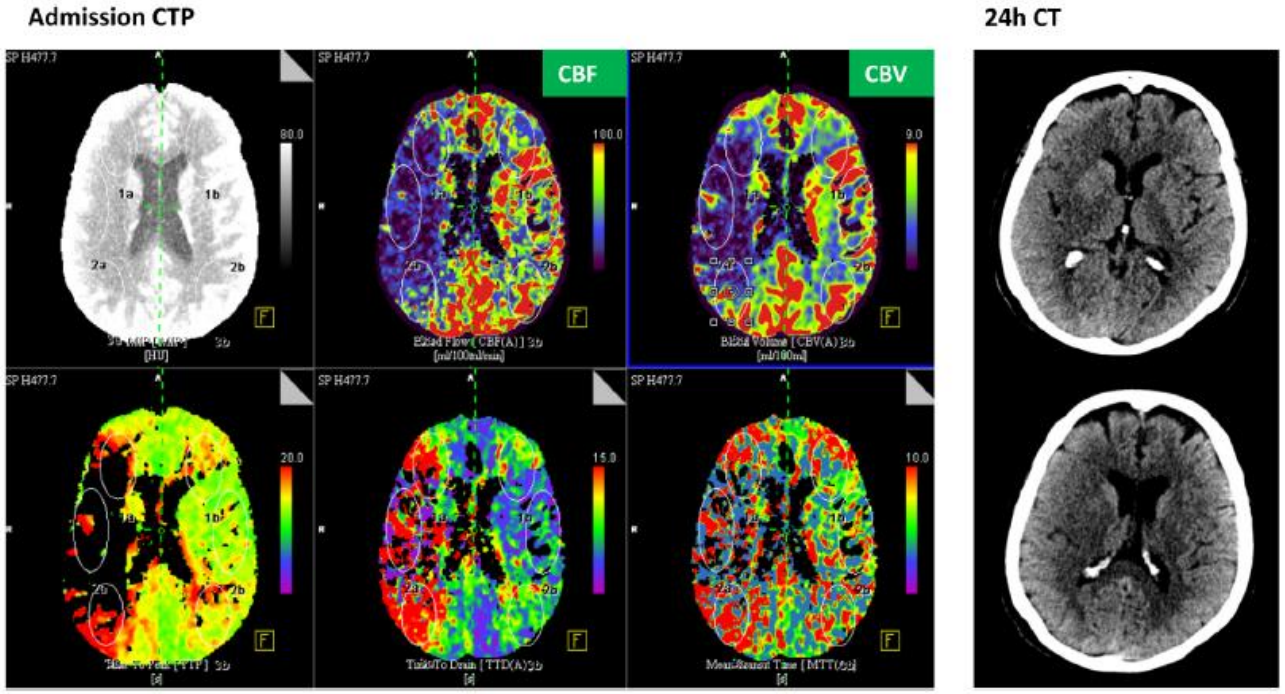


Figure 1 Patient with a final infarct volume on non-contrast CT at 24 hours that was smaller than the initial core volume on CT perfusion (CTP) at admission. In this patient the onset to CTP time was 51 min and the time from symptom to recanalization was 110 min. National Institutes of Health Stroke Scale at 24 hours was 2. CBF, cerebral blood flow; CBV, cerebral blood volume.

Conclusion

- CT perfusion may over-estimate final infarct core , especially in the early time window.

ICCA STROKE 2019

WIST

Baseline ASPECTS and e-ASPECTS Correlation with Infarct Volume and Functional Outcome in Patients Undergoing Mechanical Thrombectomy

Marta Olive-Gadea*, Nuno Martins*, Sandra Boned, Jaime Carvajal, Maria Jose Moreno, Marian Muchada, Carlos A. Molina, Alejandro Tomasello, Marc Ribo, Marta Rubiera

From the Department of Neurology, Hospital Vall d'Hebron, Stroke Unit, Barcelona, Spain (MO-G, SB, JC, MM, CAM, MR, MR); Hospital Prof. Doutor Fernando Fonseca, Internal Medicine, Amadora, Portugal (NM); and Department of Neuroradiology, Hospital Vall d'Hebron, Barcelona, Spain (MJM, AT).

Aim of the study

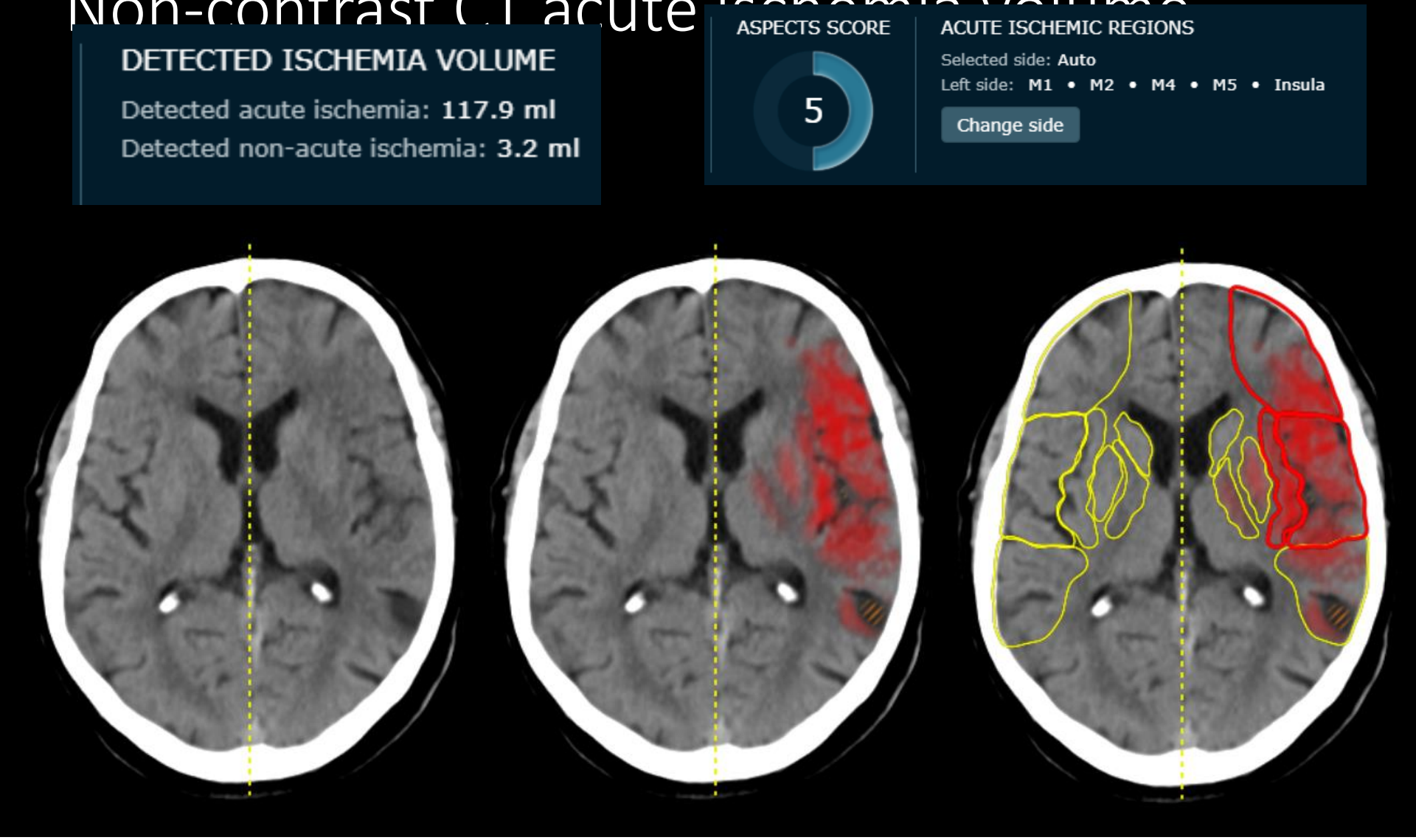
- Correlation between (Rx) and e-ASPECTS scoring with cerebral blood volume(CBV) infarct core and with final infarct volume ; as well as with long term functional outcome

e-ASPECTS

- e-ASPECTS assesses the non-contrast CT scan for **early signs of ischemia** in the MCA territory
- A "**heat map**" shows the areas of the image with detected ischemic signs (red shading)
- Non-acute ischemia is highlighted separately (hatched shading)
- **Volume measurements in ml** are displayed in all results formats

Brainomix

Non-contrast CT acute ischemia volume



Brainomix

Demographics & Clinical Characteristics of patients

Female		113 (61.4%)
Age (years)		73.14 (±12.11)
Etiology	Atherothrombotic	6 (3.3%)
	Cardioembolic	123 (66.8%)
	Undetermined	45 (24.4%)
	Other (dissections)	10 (5.4%)
Baseline NIHSS		18 (IQR 13–20)
Time to CT (minutes)		191.25 (±153.10)
Baseline Rx-ASPECTS		9 (IQR 8–10)
Baseline e-ASPECTS		9 (IQR 7.75-10)
Baseline CBV, mL		29.51 (±47.41)
Occlusion on CTA	MCA-M1	159 (86.9%)
	Proximal ICA	24 (13.1%)
rtPA		89 (48.6%)
Time to groin puncture (minutes)		226.9 (±138.5)
Final TICI score, *n*/total	0-1	11 (5.9%)
	2a	21 (11.4%)
	2b	67 (36.4%)
	3	84 (45.7%)
Final infarct volume (mL)		54.02 (±89.5)

NIHSS = National Institute of Health Stroke Scale; CBV = cerebral blood volume; CTA = CT angiography; MCA = middle cerebral artery; ICA = internal carotid artery; rtPA = tissue plasminogen activator; TICI = thrombolysis in cerebral infarction.

Correlation between baseline radiologist assessed ASPECTS (Rx-ASPECTS) and e-ASPECTS. *rs* = Spearman's rank correlation

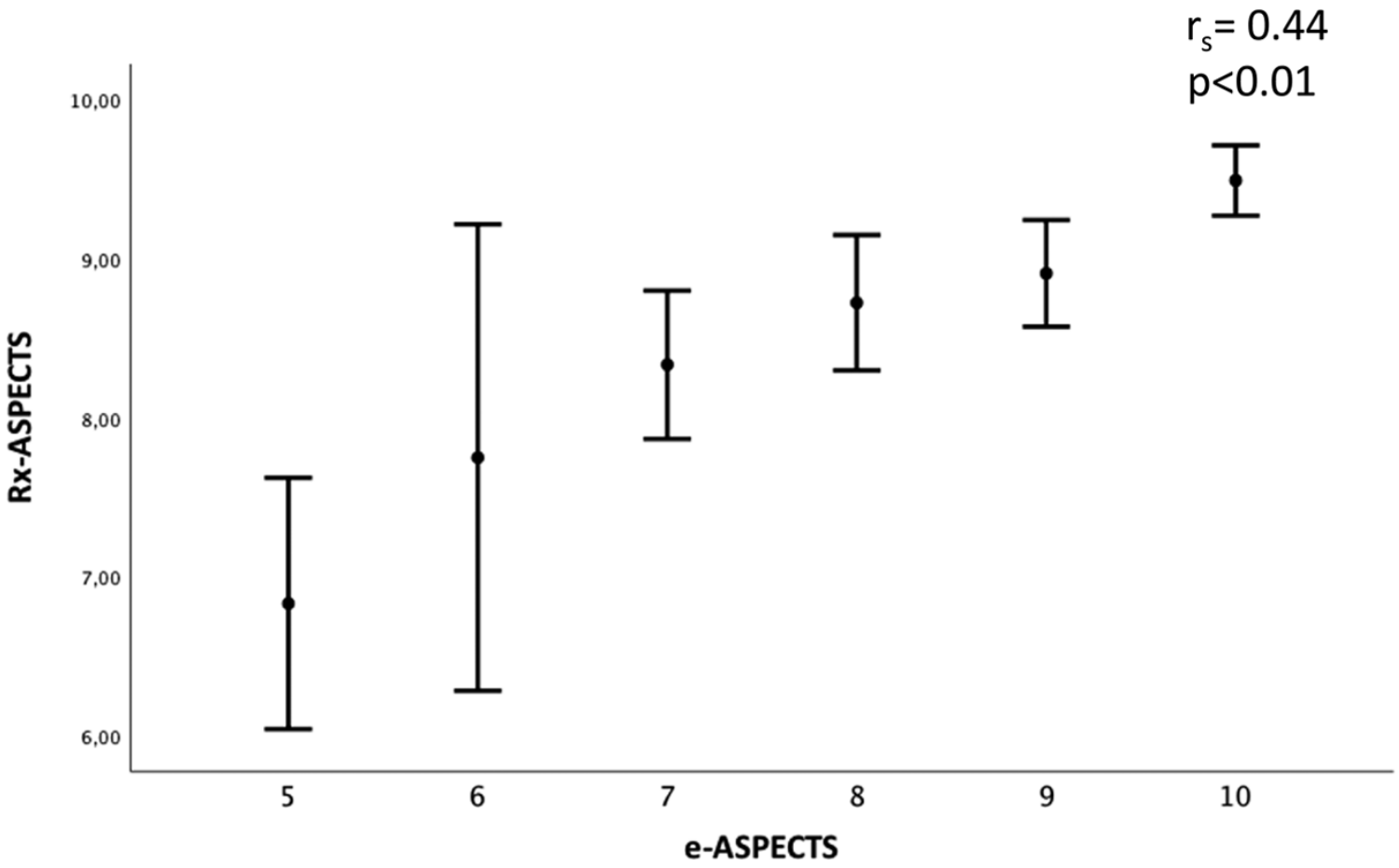
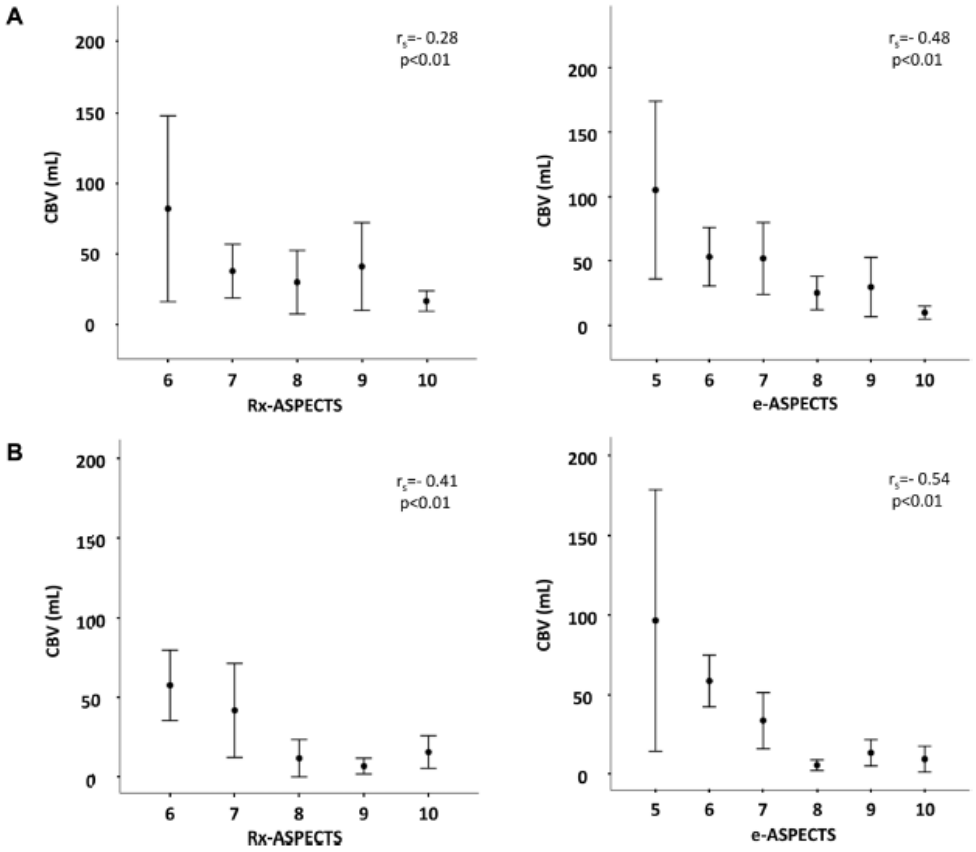
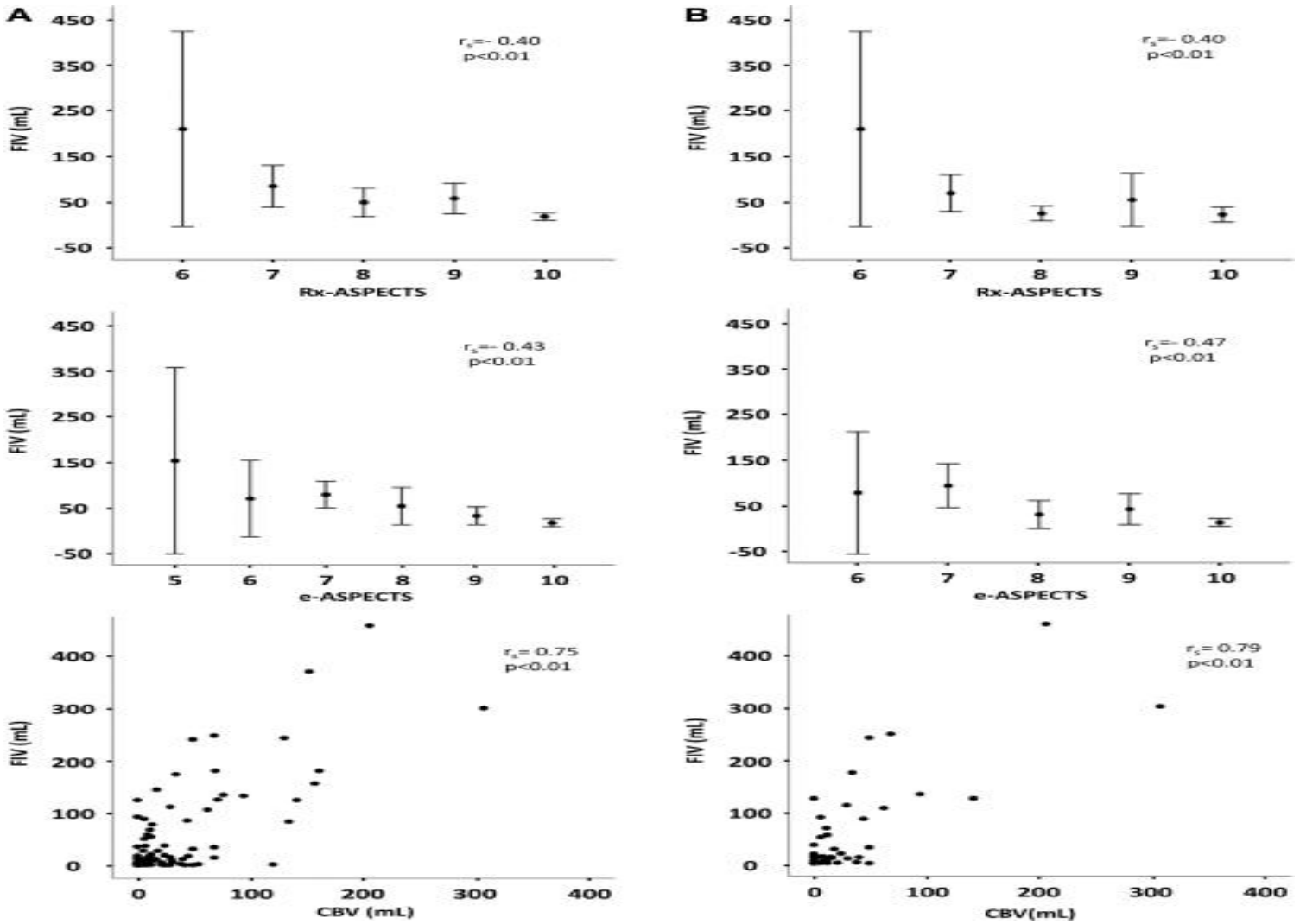


Fig 2. Correlation between baseline radiologist assessed ASPECTS (Rx-ASPECTS) and e-ASPECTS with cerebral blood volume (CBV) ischemic core on CT perfusion: in (A) all patients and (B) > 180 minutes. r_s = Spearman's rank correlation coefficient.



Radiologist assessed ASPECTS (Rx-ASPECTS), e-ASPECTS, and cerebral blood volume (CBV) correlation with final infarct volume
(FIV) in patients with complete recanalization: in (A) all patients and (B) >180 minutes.



Conclusion

- ASPECTS and e-ASPECTS showed a mild correlation with CBV.

- Rx-ASPECTS, e-ASPECTS and CBV predicted a low infarct volume after thrombectomy in recanalised patients but only Rx-ASPECTS and e-ASPECTS predicted functional independence at 3 months

Summary

- First the guidelines (AHA/ASA and the very fresh ESO guidelines) are consistent (Turc and Powers papers):

  No place for perfusion <6hrs for stroke thrombectomy (10% of patients)

  Only value is in 6-24hrs, but this is a small number of patients (1-2%)

- Nagel et al 2018 demonstrates that the results of patients from 6-24 hours without advanced imaging (selected on e-ASPECTS and clinical features alone) do similarly well to the trial cohorts.
- Olive-Gadea 2018 shows that e-ASPECTS /ASPECTS performs better than CTP (RAPID) in predicting outcome in patients with recanalization.

- Boned 2017 shows that early on CTP may deny patients treatment unfairly (ghost core phenomenon)

Question-Is perfusion always necessary?

NO

ICCA STROKE 2019

WIST

Thank you